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NOX EMISSION REDUCTION OF CI ENGINE USING OPTIMIZED DUAL BLEND BIODIESEL

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ABSTRACT

This experimental work was conducted on four strokes, single cylinder with variable compression ratio with optimized biodiesel blend of soybean methyl ester and rapeseed methyl ester biodiesels blended with each other in two different ratios. Outcomes investigated and compared with standard diesel fuel. An experiment has been conducted at compression ratios of 16:1, 17:1, and 18:1. The impact of compression ratio on mechanical efficiency and exhaust gas emissions like Nitrogen oxides (NOx), carbon mono oxide (CO), hydrocarbon (HC), has been presented. It was concluded that NOx emission was higher at without blended biodiesel operation compared with diesel fuel and it was opposed by dual biodiesel blending. According to experimental values, there was 28% to 50% reduction at 25 % and 50 % load conditions in NOx emission. There was a 30 % reduction in carbon mono oxide emission and 35 % reduction HC emissions for the optimized blend of 80 % soybean methyl ester and 20% rapeseed methyl ester.

***KEYWORDS**: Dual Blend, Variable compression Engine, Optimization & Biodiesel*

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Original Article

INTRODUCTION

German inventor Rudolf Diesel predicts the use of vegetable oils for engine fuel in future. This foresight becomes true for modern days. Vegetable oils and animals oils became as important as petroleum products of the present time. Different researches based on the engine performance tests and their emissions have recognized the possibility of using vegetable oils as well as animal oils.[1-4] Vegetable oils from different crops grown in different areas such as soybean, sunflower, rapeseed, coconut, cottonseed, mustard, jatropha, and linseed have been evaluated as the potential source of biodiesel. The main troubles allied with the utilization of vegetable oils in the broad scenario are due to their high values of viscosity and instability. Different processes have established to overcome these difficulties are preheating of oil, blending with low viscosity oils, Micro-emulsion technique, trans-esterification process. In present days trans-esterification is a fundamental process for producing biodiesel from vegetable oils in industry. The trans-esterification of oil has done by different reaction of triglycerides with alcohol to create methyl or ethyl esters and bi-product glycerol during the process.[5-6] Emission standards and environmental concerns put emphasis on NOx variations andit has cleared through different studies that for NOx emissions reduction with biodiesel can be achieved by fuel modification approach.[7] Present work highlighting these reduced emissions values of soybean and rapeseed biodiesel and their blends.

EXPERIMENTAL PROCEDURE

In this present experimental work, a variable compression ratio engine was used with three different compression ratio (16:1, 17:1, 18:1) to assess the performance of engine parameter as well as emissions parameters. The outcomes were evaluated against the conventional diesel fuel for different loads on the engine with different compression ratio. This experimental work carried out with two phases, the first one was a preparation of biodiesel blend and other was performance analysis with engine parameters and emissions.

Fuel Preparation

The vegetable oils were acquired from viable sources and then samples were converted to methyl esters by a trans-esterification process. The trans-esterification process also known as alcoholysis process where vegetable oil processed through an alcohol to form methyl esters or ethyl esters. Then the prepared mixture is maintained at a temperature 62^{o}C and constantly stirred for one hour. Present experimental work carried out with two components; Soybean methyl ester and Rapeseed methyl esters and its comparison with their dual blends and with conventional diesel fuel. Physical fuel properties have a linear relationship with their ratios of blending. Properties like density, flash point, calorific value, kinematic viscosity and cetane number show this connection according to blend ratio and it is very useful in the determination of the optimum blending ratio by linear equations by using software programming. As a result, the two dual biodiesel blends were prepared for tests. Blend preparation done by a simple mixing of two biodiesel soybean methyl ester and rapeseed methyl esterin 50% each by volume and another one which has 80% soybean methyl esters and 20% rapeseed methyl esters.

Experimental Set-up

Conventional diesel fuel has been taken for comparison and base parameter for all observationfor this experiment. The experimental engine was a variable compression ratio engine with an integrated feature of the engine performance software package. The automotive Gas analyzer was used for engine emission analysis. In this study, the engine was run at the constant speed of 1500 rpm at different engine loadings of zero, 25%, 50%, 75% and 100% with different compression ratio 16:1, 17:1 and 18:1. The performance of engine and exhaust gases emission data for Diesel, soybean methyl ester (SME), rapeseed methyl ester (RME), blend of soybean methyl ester-50% and rapeseed methyl ester -50% by volume (B55) and Blend of soybean methyl ester-80% and rapeseed methyl ester -20% by volume (B82) were recorded and analyzed. This experimental was carried out to explore the performance parameters and exhaust emission parameters of biodiesel blend by volume basis in variable compression ratio and compared with diesel fuel. Table 1 shows the specification of the experimental engine setup.

Table 1: Specification of Variable Compression Ratio Engine

General Details	4-Stroke, Water Cooled, VCR
Rated power	4.5 kW at 1500 rpm
Speed	1500 rpm
Number of cylinder	Single cylinder
Compression ratio	12:1–18:1
Bore	87.5 mm
Stroke	110 mm
Ignition	Compression ignition

RESULTS

Mechanical Efficiency

Mechanical efficiency is expressed as a ratio of brake power to indicated power. It is also used to represent to calculate power and to estimate friction losses. Reduction in mechanical efficiency of biodiesel is principally due to the high density of ester and instability which directly influences the fuel atomization and produces a poor degree of combustion. Figure 1 shows the graph between mechanical efficiency and various compression ratios at 100 % load condition. In this graph, conventional diesel fuel showed the highest value among all biodiesel and their blends. B82 (SME-80%, RME-20%) has near about values with diesel and at compression ratio 16:1 and 18:1, clearly overlapped mechanical efficiency shown in Figure 1.

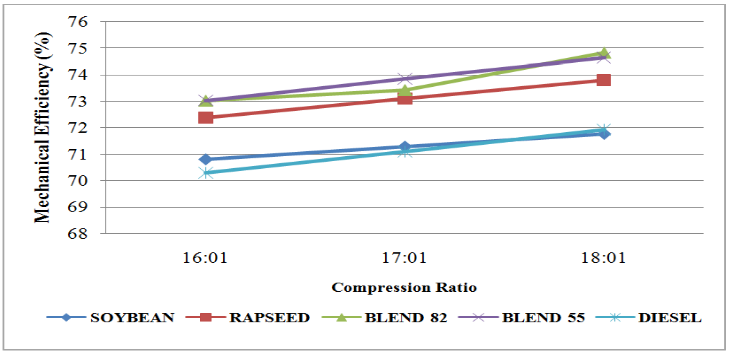

Figure 1: Variation of Mechanical Efficiency with Different Compression ratio at 100 % Load Condition

Nitrogen Oxides Emissions

Figure 2 demonstrates the deviations of NOx emissions for different fuel blends at a 25 % load condition at different compression ratio (16:1, 17:1, and 18:1). Experimental data showed that exhaust NOx emission increased with increasing of a load. The observed value of NOx emission was found at the compression ratio of 18:1 was 215ppm for diesel and 113ppm for B82 (SME-80%, RME-20%). Figure 3shows the variation of NOx emission for diesel, SME, RME, B55, and B82, for 50% load condition. Again conventional diesel fuel's NOx emission was higher than all biodiesel and their blends.

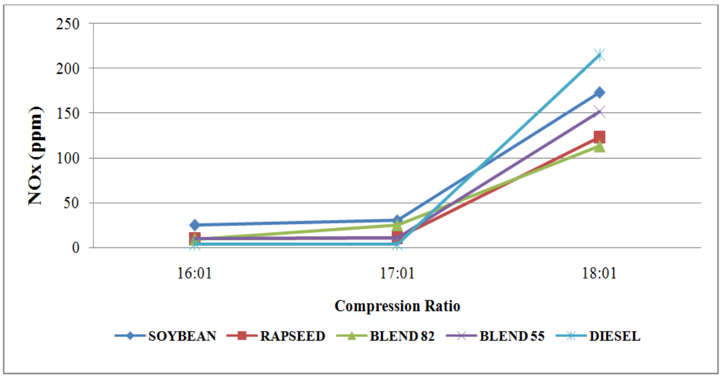

Figure 2: Variation of NOx Emissions with Different Compression Ratio at 25 % Load Condition

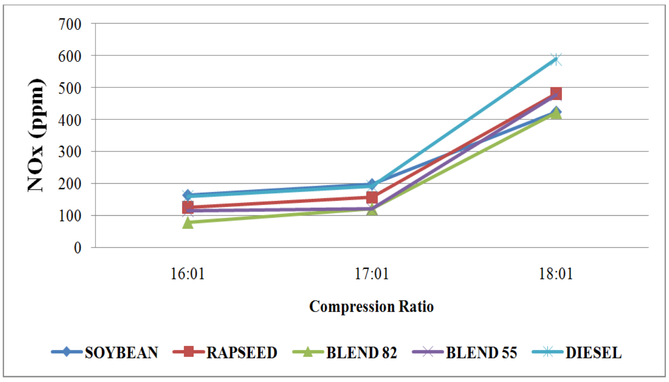

Figure 3: Variation of NOx with Fuels Blends for Different Compression Ratio at 50% Load

Hydrocarbons Emissions

HC emissions consist of fuel that is entirely unburned or incompletely burned inside the combustion chamber. The amount of Hydro Carbon emission completely depends on the operating condition of the engine and used fuel properties. Figure 4 shows a deviation of HC emissions for all biodiesels and diesel for 100 % load condition at different compression ratios. At the higher compression ratio, HC was low due to higher temperature and better combustion process. Figure 4 shows Hydro Carbon emission for conventional diesel and biodiesel blends for 100% load at variable compression ratios. Experimental data shows blending techniques increases ignition delay, and additionally, oxygen improvement is always encouraging oxidation of HC in the exhaust process.

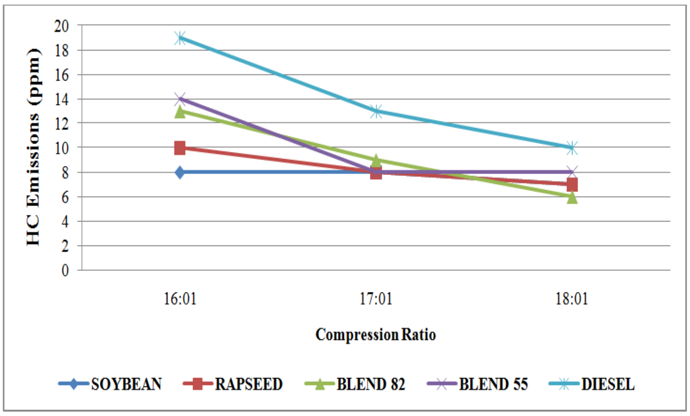

Figure 4: Variation of HC Emission with Fuels Blends for Different Compression Ratio at Maximum Load

Carbon Monoxide Emissions

Formation of Carbon monoxide ensures poor combustion and less supply of oxygen and deficient mixture preparation during the process of fuel combustion. Figure 5 shows the exhaust emission variation of CO for all fuels used in experimental work at different compression ratio and 50% load. Figure 5 shows the CO emission has decreased with an increase in compression ratio for all biodiesel blends as compared with the diesel.

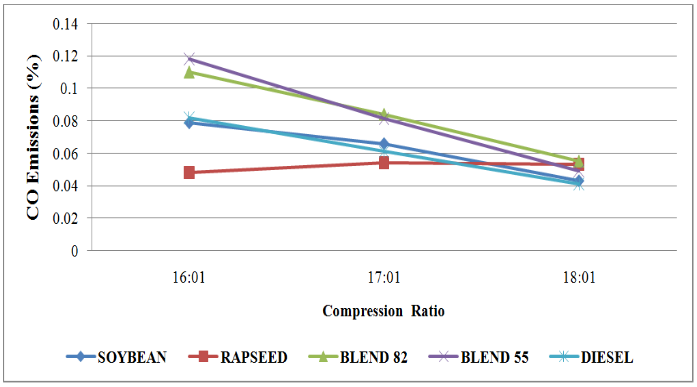

Figure 5: Variation of CO Emission with Fuels Blends for Different Compression Ratio at 50% Load

CONCLUSIONS

In this experimental study, the effect of engine mechanical efficiency and exhaust emission performance parameter of soybean methyl ester and rapeseed methyl ester l and its two blends B55 (SME-50%, RME-50%) and B82 (SME-80%, RME-20%) with diesel fuel have been examined and by experimental observations, conclusions are abridged as follows:

- The variable compression ratio diesel engine runs efficiently with all the prepared blends and there was no need of modification in engine geometry or in a combustion chamber. All biodiesel blends show lower brake power as compared to diesel. Blend B82 (SME-80%, RME-20%) showed the average valueof mechanical efficiency, only 3-4% lesser than diesel engine at variable compression ratios.
- The NOx exhaust emission for blend B82 (SME-80%, RME-20%) was around 50%,36%, and 28% lower than that of diesel at compression ratio 16:1, 17:1 and 18:1 respectively. NOx emissions were observed lower also for B55 (SME-50%, RME-50%).
- B82 (SME-80%, RME-20%) biodiesel has the potential to reduce carbon monoxide and hydrocarbon exhaust emissions. Using B82 biodiesel reduced the quantity of CO about 23%- 39 % as compared with diesel for variable compression ratio and different loads on the engine.
- During the experiment, values of hydrocarbon emissions compared to conventional diesel fuel, HC emissions 31 %- 40% lesser for maximum load at different compression ratios.

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